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During training and routine operations or in combat situations on land and sea or in the air, Sailors and Marines can be exposed to directed energy (DE) radiation in the form of laser emissions, microwaves, or radiofrequency radiation. Sources of DE radiation include telecommunications systems, radars, navigational systems, range finders, target designators, and directed energy weapons employing laser and microwave technologies. Determining safe exposure conditions for military personnel working with or near DE devices requires an extensive scientific database and a knowledge of the exposure configurations for normal working situations and for accidental or purposeful overexposure situations.

Navy researchers and technicians (physiological and experimental psychologists, engineers, visual scientists, biologists, computer specialists, corpsmen and data analysts) at NHRC DET (Brooks) are investigating the bioeffects of directed energy in order to optimize performance of Navy and Marine Corps personnel and enhance warfighter protection. Their work includes controlled laboratory experiments and field studies with deployed units. The microwave and radiofrequency radiation studies are contributing to the national safety standards and DoD Instruction 6055.11 *Protection of DoD personnel from exposure to electromagnetic field (EMF) at radiofrequencies (RF) from 3kHz to 300 GHz*. The laser studies are helping scientists to design computer-based mission planning and mission rehearsal systems by quantifying the relationship between laser exposures, laser-induced short and long-term changes in visual function, and the impact of laser glare on visual performance in aviation operating environments.

NHRC DET (Brooks) is part of a joint team conducting cooperative research at the Tri-service Frank M. Tejeda Directed Energy Bioeffects Complex at Brooks Air Force Base.

Research areas:

- Health and safety of naval forces in non-battle DE operating environments
- Threat countermeasures in hostile DE operating environments (battlefield uses of directed energy weapons)
- Care and management of DE casualties

USS Reliance

Research is conducted on a land-locked simulated carrier deck where scientists create realistic shipboard situations. The Navy and Air Force built a 60-ft by 60-ft outdoor groundplane irradiation facility at Brooks AFB, San Antonio, TX with the look and feel of an aircraft carrier deck. A USMC “Black Knight” squadron F/A-18 Hornet is permanently tethered to the site. This simulated deck, christened the *USS Reliance* in 1996, is the only one in DOD being used for biomedical research.

Visit NHRC Detachment (Brooks) at http://www.brooks.af.mil/NHRC/nhrc.htm

Research

Microwave (MW) and Radiofrequency Radiation (RFR)

- Microwaves and RFR are used extensively for communication, target acquisition, electronic warfare and other military purposes. Remote deployments and significant engagement distances encountered in modern warfare rely on MW and RFR and nearly all MW/RFR emitters onboard ships have very high power output. Protection of personnel requires avoidance of radio frequency antennas and microwave beams or restriction to areas where there are safe levels of exposure. Scientists are actively engaged in determining a safe level of exposure by conducting research on the biological effects produced by absorption of MW and RFR energy.

Bioengineering

- Individuals exposed to RFR or MW energy scatter and absorb that energy depending on many factors such as wavelength, body size, body shape, and orientation. Absorption aboard Navy ships is complex and can depend on reflections from nearby objects such as aircraft or other structures. Researchers are developing methods to measure RFR and MW energy absorption using full-scale human models and calorimeters. Over the past 12 years, Navy-developed dosimetry methods and tools have been used at many DOD installations and in a number of foreign countries such as Germany, Finland, and Australia.

Laser

- Scientists conduct research to support the health and safety of personnel likely to be exposed to laser radiation in military operating environments. Current studies focus on the relationship between retinal laser exposure and changes in retinal morphology and visual function, the impact of laser glare and laser eye protection on visual performance, and the transition of research products to the aviation community by modeling laser bioeffects in computer-based mission planning and mission rehearsal systems.

Examples of Accomplishments

- Research efforts contribute to the setting of national safety standards for protection of personnel from exposure to electromagnetic fields.
- The Navy-developed resonant RF coil system was originally intended for hypothermia resuscitation. It has now been combined with a simple neuromuscular stimulator to alleviate the deleterious effects of many physical problems associated with vascular insufficiency in the extremities such as diabetic neuropathy and carpal-tunnel syndrome.
- Investigators developed methods to measure RFR and microwave energy absorption in personnel using full-scale human models and calorimeters.
- Investigators are developing a validated human electromagnetic field dosimetry modeling system based on finite difference time domain procedures (FD-TD) which will improve assessments of potential health effects, facilitate accident reconstruction, simulate directed energy weapons exposures, and ensure that experimental exposures accurately model potential human exposures.

Examples of Operational Support

- Researchers provide Laser Systems and Threats briefings at the Weapons and Tactics Instructor Course at the Naval Strike and Air Warfare Center in Fallon, NV.
- Detachment supports the International EMF Dosimetry Project. An international resource that provides state-of-the-art electromagnetic field dosimetry and promulgates a Radiofrequency Radiation Dosimetry Handbook.
- Researchers provide joint assessments of human effects and countermeasures for existing and emerging foreign laser and MW/RFR systems.
- The Laser Department is supporting the Naval Air Warfare Center – Aircraft Division through laboratory and field tests of laser-related systems currently under development.
- The implementation of the DoD Instruction 6055.11, *Protection of DOD personnel from exposure to electromagnetic fields at radio frequencies from 3kHz to 300 GHz.*
- The Laser Threat and Mission Planning System will provide intelligence analysts with the visualization tools needed to evaluate directed energy warfare threats and impacts.
- Researchers joined with the Air Force and Army to focus on integrating laser hazard models for all three services. The website for the team is http://www.brooks.af.mil/AFRL/HED/HEDO/ltmc.htm